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2775. Proposed by H. T. BURGESS, University of Wisconsin.

Solve in finite form, if possible, the differential equation

$$\frac{d^2y}{dt^2} + ay\frac{dy}{dt} + by = g,$$

when a and b are arbitrary constants and $g = 32.16$. When $t = 0$, $y = 0$, $dy/dt = 0$.

As solutions have not been received for more than 130 problems proposed since January, 1913, the number of *new* problems proposed each month is to be considerably reduced and *old* problems are to be reproposed. Solutions are desired for the following problems proposed before January, 1918:

Algebra—406, 411, 416, 417, 461, 481, 494.
Geometry—442, 446, 455, 463, 470, 472, 476, 477, 478, 499, 501, 510, 519, 523.
Calculus—348, 349, 353, 406, 415, 429, 432, 434, 436.
Mechanics—287, 291, 300, 308, 309, 313, 315, 332, 343, 344, 351.
Number Theory—198, 201, 202, 205, 231, 232, 234, 238, 245, 247, 263, 266, 270, 272, 273, 274, 275.

430 (Algebra) [March, 1915]. Proposed by V. M. SPUNAR, Chicago, Illinois.

Solve the following equations both algebraically and graphically:

$$x^y + y^x = xy, \qquad x^x + y^y = x + y.$$

339 (Calculus) [June, 1913]. Proposed by T. H. GRONWALL, New York, N. Y.

To show that for any real value of x

$$\left|\frac{d^n}{dx^n}\left(\frac{\sin x}{x}\right)\right| \leqq \frac{1}{n+1}, \quad \text{and} \quad \left|\frac{d^n}{dx^n}\left(\frac{1-\cos x}{x}\right)\right| \leqq \frac{1}{n+1}.$$

340 (Calculus) [June, 1913]. Proposed by C. N. SCHMALL, New York, N. Y.

A pencil of parallel rays of light is incident upon a lens whose faces have the radii r_1, r_2, respectively. Show that the distance of the principal focus from the center of the first face of the lens will be a maximum or a minimum when

$$\frac{r_1}{r_2} = \frac{(\mu - 1)^{1/2}}{1 + (\mu - 1)^{1/2}},$$

where μ has its usual meaning.

272 (Mechanics) [February, 1913]. Proposed by J. F. LAWRENCE, Stillwater, Okla.

A perfectly rough circular cylinder is fixed with its axis horizontal. A sphere is placed on it in a position of unstable equilibrium, and projected with a given velocity parallel to the axis of the cylinder. If the sphere be slightly disturbed in a horizontal direction perpendicular to the direction of the axis of the cylinder, determine at what point the sphere will leave the cylinder.

277[1] (Mechanics) [June, 1913]. Proposed by W. J. GREENSTREET, Editor of the Mathematical Gazette, England.

Around a smooth fixed circular pulley is wound a massless inextensible string, and straight portions go to two free ends A and B to which masses are fastened. The mass at A is initially projected perpendicular to the string while the other is initially at rest. The length of the straight portion to the first mass is initially l and subsequently is r. Find the velocity of the second mass at that moment.

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[1] Incorrectly numbered 272 when first proposed.

279[1] (Mechanics) [September, 1913]. Proposed by W. W. LANDIS, Dickinson College.

A dam backs up the water for two miles. If the dam is raised 18 inches, will the water two miles up the stream be raised 18 inches, more or less?

191[2] (Number Theory) [June, 1913]. Proposed by L. E. DICKSON, University of Chicago.

Find an amicable number triple by solving one of the equations (other than the last) in the MONTHLY, March, 1913, page 92. Note that a solution a is to be excluded if not prime to the numbers in the same line.

192[3] (Number Theory) [June, 1913]. Proposed by the late ARTEMAS MARTIN.

Find rational values for v, w, and x that will satisfy simultaneously the conditions

$$(m^2+n^2)(v^2+w^2+x^2)^2-4m^2n^2v^2+m^2n^2(m^2+n^2)=0,$$

$$(m^2+n^2)(v^2+w^2+x^2)^2-4m^2n^2w^2+m^2n^2(m^2+n^2)=0,$$

$$(m^2+n^2)(v^2+w^2+x^2)^2-4m^2n^2x^2+m^2n^2(m^2+n^2)=0,$$

m and n being known quantities.

196[4] (Number Theory) [September, 1913]. Proposed by CHARLES MACAULAY, Chicago, Ill.

Combinations containing an even number of letters are formed of the letters a, b, c, d, etc. It is required to place the letters in two columns, so that half the letters in every combination are placed in one column and the other letters of the combination in the other column, and so that all the a's are placed in the same column; all b's in the same column; all the c's in the same column, etc.

SOLUTIONS OF PROBLEMS.

2667 [January, 1918]. Proposed by E. L. REES, University of Kentucky.

Given one diagonal of a parallelogram and the area of the rectangle whose sides are equal to those of the parallelogram, construct the parallelogram so that the diagonal shall make a given angle, α, with a given line and so that the sum of the angles that two adjacent sides make with this line shall be equal to a given angle, β.

2682 [March, 1918]. Proposed by E. L. REES, University of Kentucky.

Given the diagonal and the angle it makes with the bisector of one of the angles of a parallelogram. Construct the parallelogram so that the rectangle having sides equal to those of the parallelogram may have a given area.

SOLUTION BY THE PROPOSER.

If we place one end of the diagonal at the origin in the complex plane and let the fixed line be the real axis, it will be seen at once that what we have given is equivalent to the sum and product of the complex numbers represented by two of the vertices of the required parallelogram. Let this sum and product be denoted by a and b respectively, where mod a = length of diagonal, amp $a=\alpha$, mod b = given area, amp $b=\beta$.

The solution of our problem then requires merely the construction of the complex roots of the quadratic equation $x^2-ax+b=0$. This construction is effected by carrying out the operations indicated in the formula $x=a/2\pm\sqrt{[(a/2)^2-b]}$ all of which are possible with ruler and compasses.

It will be noted that problem no. 2682 is a special case of no. 2667 and hence the method of solution here suggested is applicable also to it.

Also solved by H. N. CARLETON.

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[1] Incorrectly numbered 274 when first proposed.

[2] Incorrectly numbered 187 when first proposed.

[3] Incorrectly numbered 188 when first proposed.

[4] Incorrectly numbered 192 when first proposed.